
CHAPTER 12 Aggregate Demand II: Applying the *IS-LM* Model

Questions for Review

1. The aggregate demand curve represents the negative relationship between the price level and the level of national income. In Chapter 10, we looked at a simplified theory of aggregate demand based on the quantity theory. In this chapter, we explore how the *IS-LM* model provides a more complete theory of aggregate demand. We can see why the aggregate demand curve slopes downward by considering what happens in the *IS-LM* model when the price level changes. As Figure 12-1(A) illustrates, for a given money supply, an increase in the price level from P_1 to P_2 shifts the *LM* curve upward because real balances decline; this reduces income from Y_1 to Y_2 . The aggregate demand curve in Figure 12-1(B) summarizes this relationship between the price level and income that results from the *IS-LM* model.

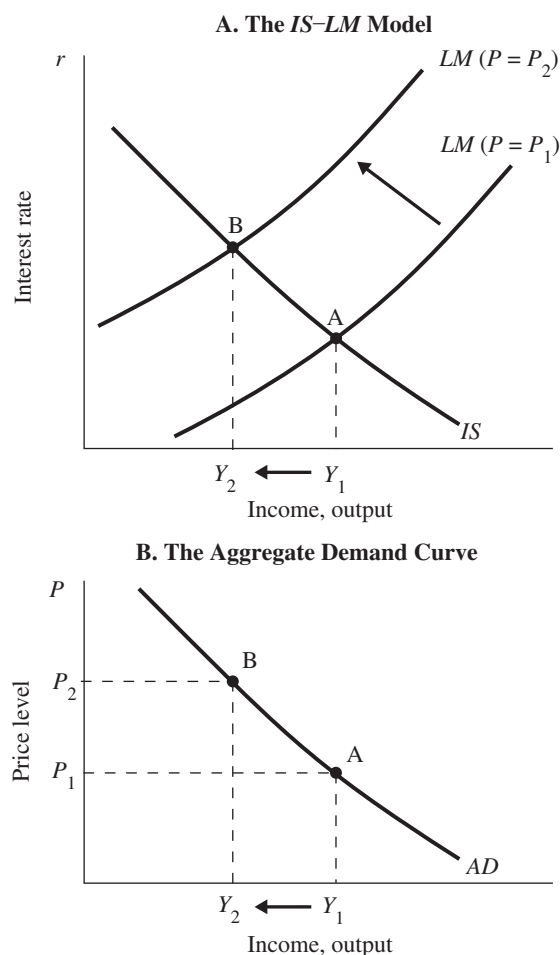


Figure 12-1

2. The tax multiplier in the Keynesian-cross model tells us that, for any given interest rate, the tax increase causes income to fall by $\Delta T \times [-MPC/(1 - MPC)]$. This IS curve shifts to the left by this amount, as in Figure 12-2. The equilibrium of the economy moves from point A to point B. The tax increase reduces the interest rate from r_1 to r_2 and reduces national income from Y_1 to Y_2 . Consumption falls because disposable income falls; investment rises because the interest rate falls.

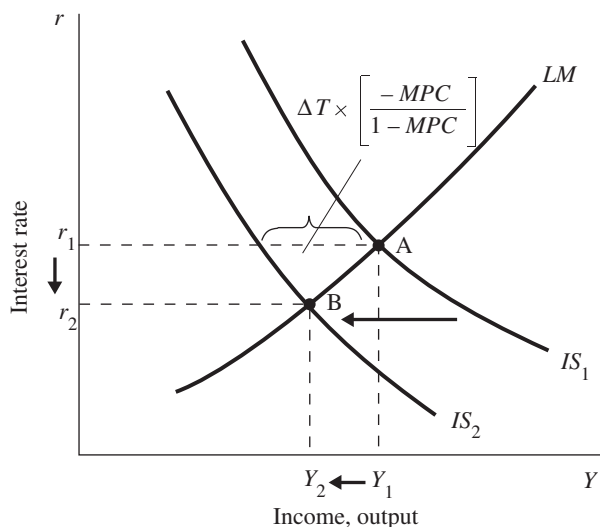


Figure 12-2

- Note that the decrease in income in the IS – LM model is smaller than in the Keynesian cross, because the IS – LM model takes into account the fact that investment rises when the interest rate falls.
3. Given a fixed price level, a decrease in the nominal money supply decreases real money balances. The theory of liquidity preference shows that, for any given level of income, a decrease in real money balances leads to a higher interest rate. Thus, the LM curve shifts upward, as in Figure 12-3. The equilibrium moves from point A to point B. The decrease in the money supply reduces income and raises the interest rate. Consumption falls because disposable income falls, whereas investment falls because the interest rate rises.

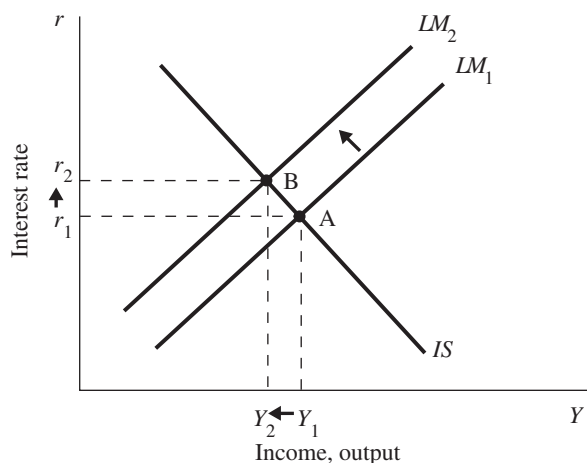


Figure 12-3

4. Falling prices can either increase or decrease equilibrium income. There are two ways in which falling prices can increase income. First, an increase in real money balances shifts the *LM* curve downward, thereby increasing income. Second, the *IS* curve shifts to the right because of the Pigou effect: real money balances are part of household wealth, so an increase in real money balances makes consumers feel wealthier and buy more. This shifts the *IS* curve to the right, also increasing income.

There are two ways in which falling prices can reduce income. The first is the debt-deflation theory. An unexpected decrease in the price level redistributes wealth from debtors to creditors. If debtors have a higher propensity to consume than creditors, then this redistribution causes debtors to decrease their spending by more than creditors increase theirs. As a result, aggregate consumption falls, shifting the *IS* curve to the left and reducing income. The second way in which falling prices can reduce income is through the effects of expected deflation. Recall that the real interest rate r equals the nominal interest rate i minus the expected inflation rate π^e : $r = i - \pi^e$. If everyone expects the price level to fall in the future (i.e., π^e is negative), then for any given nominal interest rate, the real interest rate is higher. A higher real interest rate depresses investment and shifts the *IS* curve to the left, reducing income.

Problems and Applications

1. a. If the central bank increases the money supply, then the *LM* curve shifts downward, as shown in Figure 12-4. Income increases and the interest rate falls. The increase in disposable income causes consumption to rise; the fall in the interest rate causes investment to rise as well.

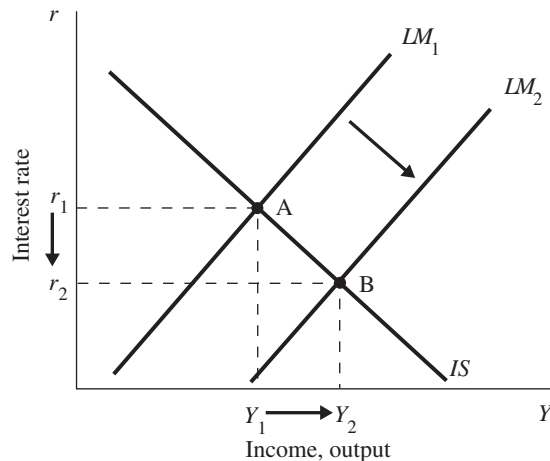


Figure 12-4

- b. If government purchases increase, then the government-purchases multiplier tells us that the IS curve shifts to the right by an amount equal to $[1/(1 - MPC)]\Delta G$. This is shown in Figure 12-5. Income and the interest rate both increase. The increase in disposable income causes consumption to rise, while the increase in the interest rate causes investment to fall.

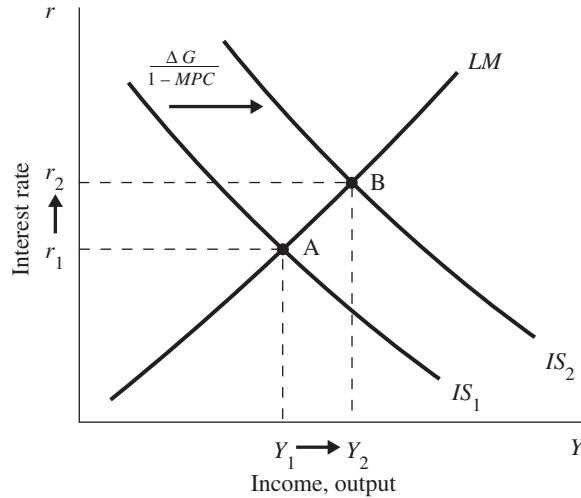


Figure 12-5

- c. If the government increases taxes, then the tax multiplier tells us that the IS curve shifts to the left by an amount equal to $[-MPC/(1 - MPC)]\Delta T$. This is shown in Figure 12-6. Income and the interest rate both fall. Disposable income falls because income is lower and taxes are higher; this causes consumption to fall. The fall in the interest rate causes investment to rise.

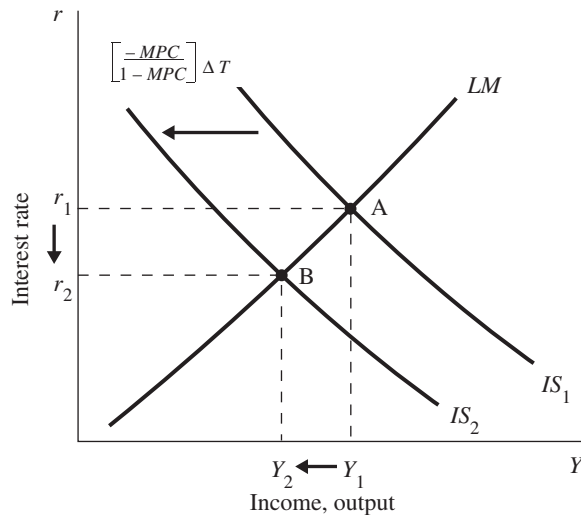


Figure 12-6

- d. We can figure out how much the *IS* curve shifts in response to an equal increase in government purchases and taxes by adding together the two multiplier effects that we used in parts (b) and (c):

$$\Delta Y = [(1/(1 - MPC))]\Delta G] - [(MPC/(1 - MPC))\Delta T]$$

Because government purchases and taxes increase by the same amount, we know that $\Delta G = \Delta T$. Therefore, we can rewrite the above equation as:

$$\Delta Y = [(1/(1 - MPC)) - (MPC/(1 - MPC))]\Delta G$$

$$\Delta Y = \Delta G.$$

This expression tells us how output changes, holding the interest rate constant. It says that an equal increase in government purchases and taxes shifts the *IS* curve to the right by the amount that *G* increases.

This shift is shown in Figure 12-7. Output increases, but by less than the amount that *G* and *T* increase; this means that disposable income $Y - T$ falls. As a result, consumption also falls. The interest rate rises, causing investment to fall.

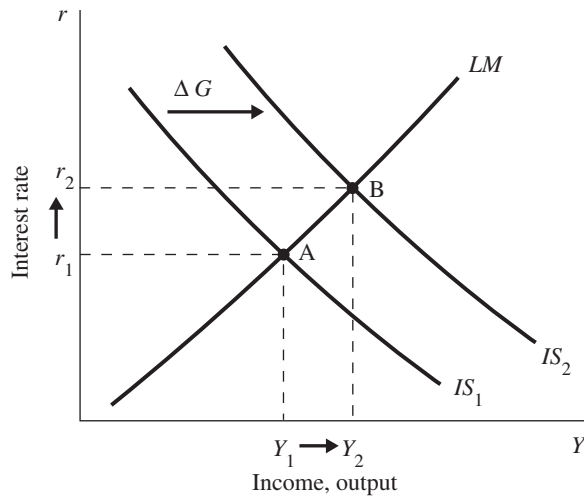


Figure 12-7

2. a. The invention of the new high-speed chip increases investment demand, meaning that at every interest rate, firms want to invest more. The increase in the demand for investment goods shifts the IS curve out and to the right, raising income and employment. Figure 12-8 shows the effect graphically.

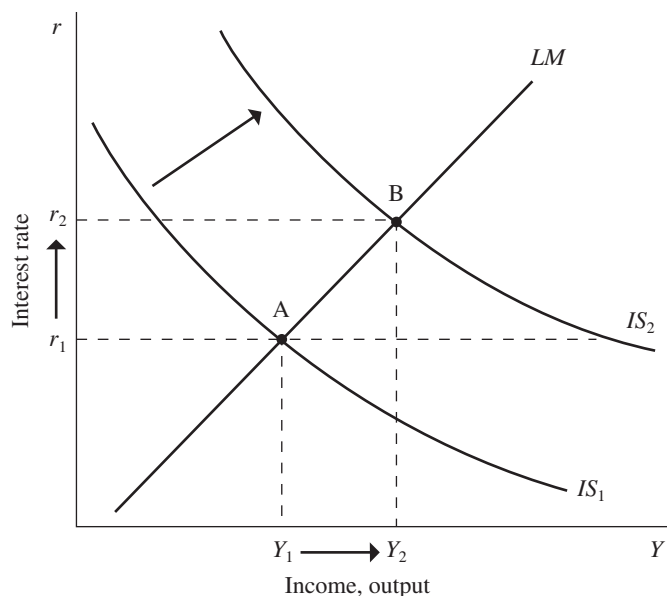


Figure 12-8

The increase in income from the higher investment demand also raises interest rates. This happens because the higher income raises demand for money; since the supply of money does not change, the interest rate must rise in order to restore equilibrium in the money market. The rise in interest rates partially offsets the increase in investment demand, so that output does not rise by the full amount of the rightward shift in the IS curve. Overall, income, interest rates, consumption, and investment all rise. If the Federal Reserve wants to keep output constant, then it must decrease the money supply and increase interest rates further in order to offset the effect of the increase in investment demand. When the Fed decreases the money supply, the LM curve will shift up and to the left. Output will remain at the same level and the interest rate will be higher. There will be no change in consumption and no change in investment. The interest rate will increase by enough to completely offset the initial increase in investment demand.

- b. The increased demand for cash shifts the LM curve up. This happens because at any given level of income and money supply, the interest rate necessary to equilibrate the money market is higher. Figure 12-9 shows the effect of this LM shift graphically.

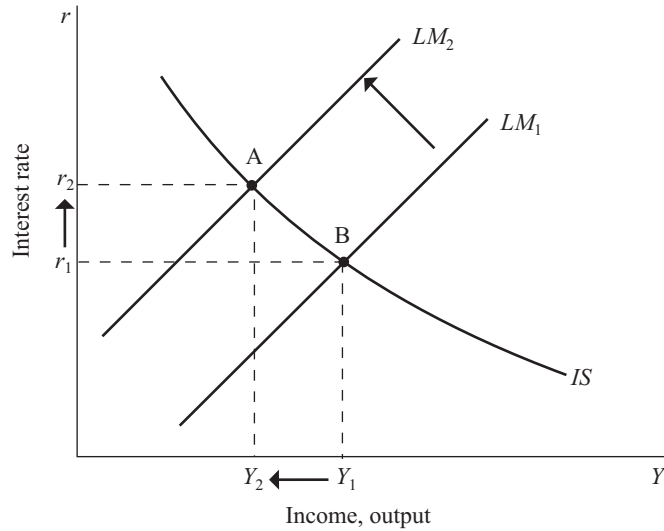


Figure 12-9

The upward shift in the *LM* curve lowers income and raises the interest rate. Consumption falls because income falls, and investment falls because the interest rate rises due to the increase in money demand. If the Federal Reserve wants to keep output constant, then they must increase the money supply in order to lower the interest rate and bring output back to its original level. The *LM* curve will shift down and to the right and return to its old position. In this case, nothing will change.

- c. At any given level of income, consumers now wish to save more and consume less. Because of this downward shift in the consumption function, the *IS* curve shifts inward. Figure 12-10 shows the effect of this *IS* shift graphically.

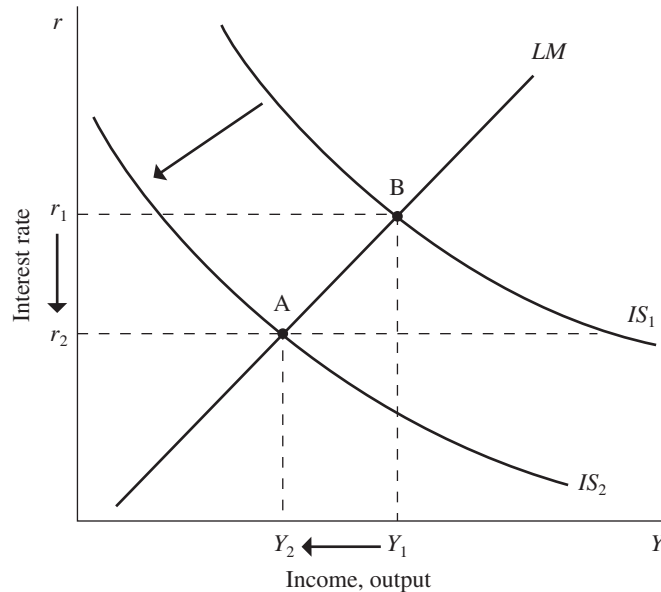
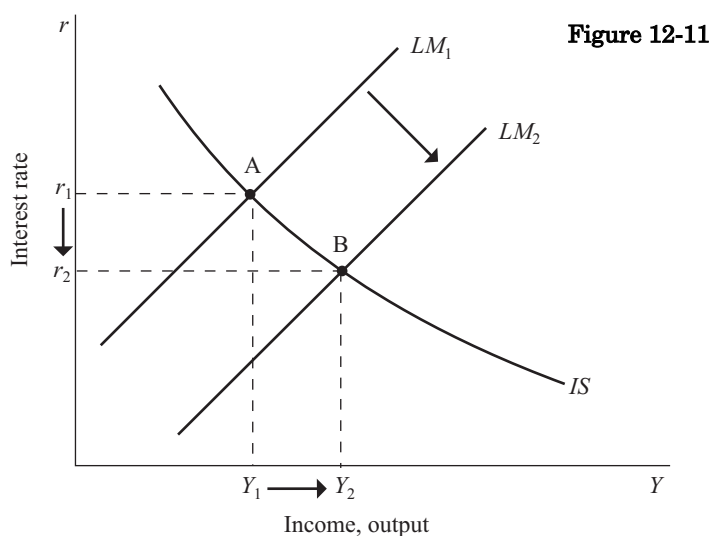


Figure 12-10

Income, interest rates, and consumption all fall, while investment rises. Income falls because at every level of the interest rate, planned expenditure falls. The interest rate falls because the fall in income reduces demand for money; since the supply of money is unchanged, the interest rate must fall to restore money-market

equilibrium. Consumption falls both because of the shift in the consumption function and because income falls. Investment rises because of the lower interest rates and partially offsets the effect on output of the fall in consumption. If the Federal Reserve wants to keep output constant, then they must increase the money supply in order to reduce the interest rate and increase output back to its original level. The increase in the money supply will shift the LM curve down and to the right. Output will remain at its original level, consumption will be lower, investment will be higher, and interest rates will be lower.

- d. An increase in expected inflation will reduce people's demand for money. This fall in the demand for money will shift the LM curve down and to the right, as illustrated in Figure 12-11.



The interest rate will have to fall to maintain equilibrium in the money market and this fall in the interest rate will increase investment spending. Equilibrium output will rise, and so will consumption. If the Federal Reserve wants to keep output constant, then it must decrease the money supply. The LM curve will shift back to its old position and nothing will change.

3. a. The IS curve is given by:

$$Y = C(Y - T) + I(r) + G.$$

We can plug in the consumption and investment functions and values for G and T as given in the question and then rearrange to solve for the IS curve for this economy:

$$\begin{aligned} Y &= 200 + 0.75(Y - 100) + 200 - 25r + 100 \\ Y - 0.75Y &= 425 - 25r \\ (1 - 0.75)Y &= 425 - 25r \\ Y &= (1/0.25)(425 - 25r) \\ Y &= 1,700 - 100r. \end{aligned}$$

This IS equation is graphed in Figure 12-12 for r ranging from 0 to 8.

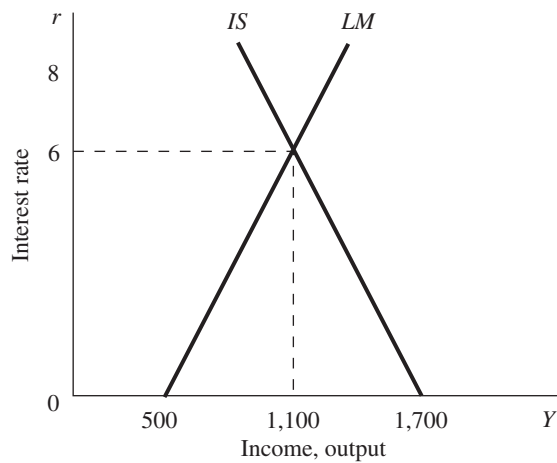


Figure 12-12

- b. The *LM* curve is determined by equating the demand for and supply of real money balances. The supply of real balances is $1,000/2 = 500$. Setting this equal to money demand, we find:

$$500 = Y - 100r.$$

$$Y = 500 + 100r.$$

This *LM* curve is graphed in Figure 12-11 for r ranging from 0 to 8.

- c. If we take the price level as given, then the *IS* and the *LM* equations give us two equations in two unknowns, Y and r . We found the following equations in parts (a) and (b):

$$IS: Y = 1,700 - 100r.$$

$$LM: Y = 500 + 100r.$$

Equating these, we can solve for r :

$$1,700 - 100r = 500 + 100r$$

$$1,200 = 200r$$

$$r = 6.$$

Now that we know r , we can solve for Y by substituting it into either the *IS* or the *LM* equation. We find

$$Y = 1,100.$$

Therefore, the equilibrium interest rate is 6 percent and the equilibrium level of output is 1,100, as depicted in Figure 12-11.

- d. If government purchases increase from 100 to 150, then the *IS* equation becomes:

$$Y = 200 + 0.75(Y - 100) + 200 - 25r + 150.$$

Simplifying, we find:

$$Y = 1,900 - 100r.$$

This *IS* curve is graphed as IS_2 in Figure 12-13. We see that the *IS* curve shifts to the right by 200.

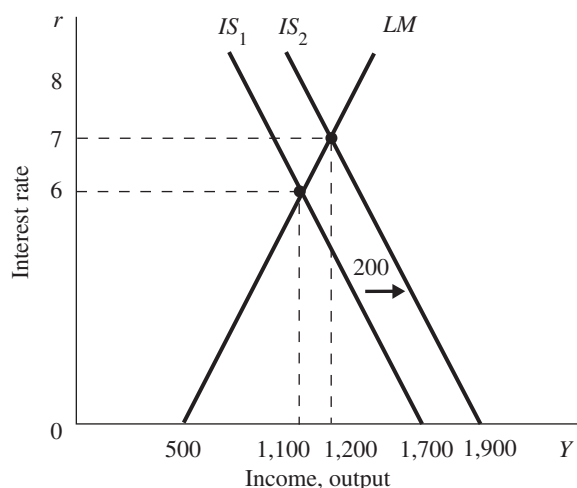


Figure 12-13

By equating the new IS curve with the LM curve derived in part (b), we can solve for the new equilibrium interest rate:

$$1,900 - 100r = 500 + 100r$$

$$1,400 = 200r$$

$$7 = r.$$

We can now substitute r into either the IS or the LM equation to find the new level of output. We find

$$Y = 1,200.$$

Therefore, the increase in government purchases causes the equilibrium interest rate to rise from 6 percent to 7 percent, while output increases from 1,100 to 1,200. This is depicted in Figure 12-13.

- e. If the money supply increases from 1,000 to 1,200, then the LM equation becomes:

$$(1,200/2) = Y - 100r,$$

or

$$Y = 600 + 100r.$$

This LM curve is graphed as LM_2 in Figure 12-14. We see that the LM curve shifts to the right by 100 because of the increase in real money balances.

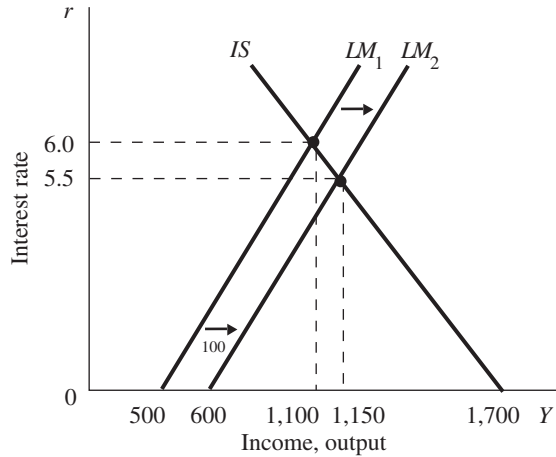


Figure 12-14

To determine the new equilibrium interest rate and level of output, equate the *IS* curve from part (a) with the new *LM* curve derived above:

$$1,700 - 100r = 600 + 100r$$

$$1,100 = 200r$$

$$5.5 = r.$$

Substituting this into either the *IS* or the *LM* equation, we find

$$Y = 1,150.$$

Therefore, the increase in the money supply causes the interest rate to fall from 6 percent to 5.5 percent, while output increases from 1,100 to 1,150. This is depicted in Figure 12-14.

- f. If the price level rises from 2 to 4, then real money balances fall from 500 to $1,000/4 = 250$. The *LM* equation becomes:

$$Y = 250 + 100r.$$

As shown in Figure 12-15, the *LM* curve shifts to the left by 250 because the increase in the price level reduces real money balances.

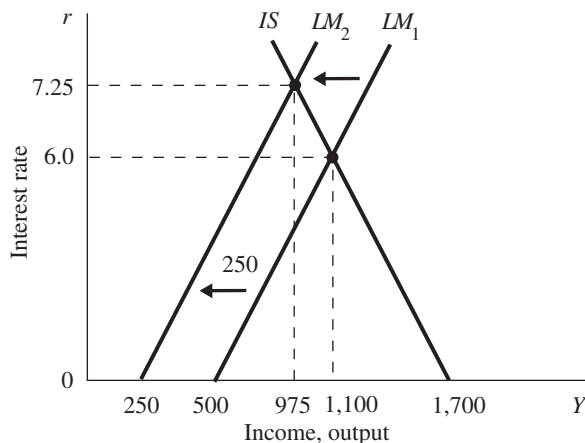


Figure 12-15

To determine the new equilibrium interest rate, equate the IS curve from part (a) with the new LM curve from above:

$$1,700 - 100r = 250 + 100r$$

$$1,450 = 200r$$

$$7.25 = r.$$

Substituting this interest rate into either the IS or the LM equation, we find

$$Y = 975.$$

Therefore, the new equilibrium interest rate is 7.25, and the new equilibrium level of output is 975, as depicted in Figure 12-15.

- g. The aggregate demand curve is a relationship between the price level and the level of income. To derive the aggregate demand curve, we want to solve the IS and the LM equations for Y as a function of P . That is, we want to substitute out for the interest rate. We can do this by solving the IS and the LM equations for the interest rate:

$$IS: \quad Y = 1,700 - 100r$$

$$100r = 1,700 - Y.$$

$$LM: \quad (M/P) = Y - 100r$$

$$100r = Y - (M/P).$$

Combining these two equations, we find

$$1,700 - Y = Y - (M/P)$$

$$2Y = 1,700 + M/P$$

$$Y = 850 + M/2P.$$

Since the nominal money supply M equals 1,000, this becomes

$$Y = 850 + 500/P.$$

This aggregate demand equation is graphed in Figure 12-16.

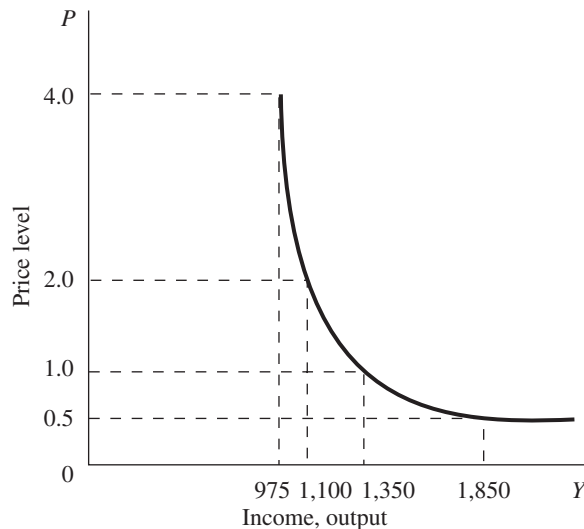


Figure 12-16

How does the increase in fiscal policy of part (d) affect the aggregate demand curve? We can see this by deriving the aggregate demand curve using the IS equation from part (d) and the LM curve from part (b):

$$\begin{aligned} IS: \quad Y &= 1,900 - 100r \\ 100r &= 1,900 - Y. \\ LM: \quad (1,000/P) &= Y - 100r \\ 100r &= Y - (1,000/P). \end{aligned}$$

Combining and solving for Y :

$$1,900 - Y = Y - (1,000/P),$$

or

$$Y = 950 + 500/P.$$

By comparing this new aggregate demand equation to the one previously derived, we can see that the increase in government purchases by 50 shifts the aggregate demand curve to the right by 100.

How does the increase in the money supply of part (e) affect the aggregate demand curve? Because the AD curve is $Y = 850 + M/2P$, the increase in the money supply from 1,000 to 1,200 causes it to become

$$Y = 850 + 600/P.$$

By comparing this new aggregate demand curve to the one originally derived, we see that the increase in the money supply shifts the aggregate demand curve to the right.

4. a. This statement is false. Investment is part of planned expenditure, so changes in investment have an impact of the IS curve and not the LM curve.
- b. This statement is true. The IS curve represents the relationship between the interest rate and the level of income that arises from equilibrium in the market for goods and services. That is, it describes the combinations of income and the interest rate that satisfy the equation

$$Y = C(Y - T) + I(r) + G.$$

If investment does not depend on the interest rate, then *nothing* in the IS equation depends on the interest rate; income must adjust to ensure that the quantity of goods produced, Y , equals the quantity of goods demanded, $C + I + G$. Thus, the IS curve is vertical at this level, as shown in Figure 12-17.

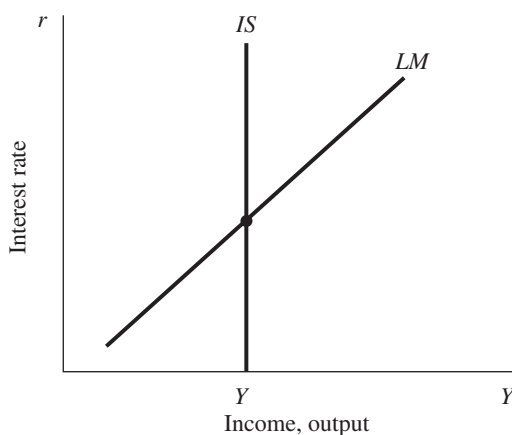


Figure 12-17

Monetary policy has no effect on output, because the IS curve determines Y . Monetary policy can affect only the interest rate. In contrast, fiscal policy is effective: output increases by the full amount that the IS curve shifts.

- c. This statement is false. Money demand helps determine equilibrium in the money market, and this will have an impact on the LM curve and not the IS curve.
- d. This statement is true. The LM curve represents the combinations of income and the interest rate at which the money market is in equilibrium. If money demand does not depend on the interest rate, then we can write the LM equation as

$$M/P = L(Y).$$

For any given level of real balances M/P , there is only one level of income at which the money market is in equilibrium. Thus, the LM curve is vertical, as shown in Figure 12-18.

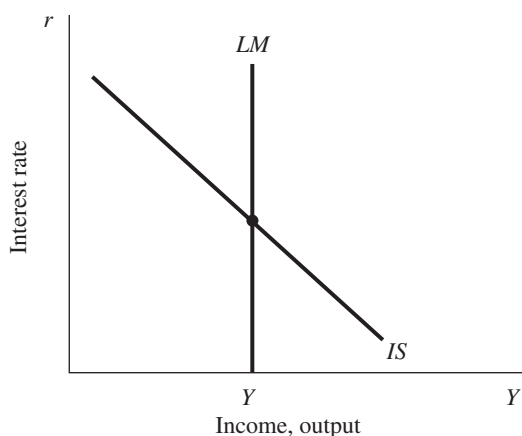


Figure 12-18

Fiscal policy now has no effect on output; it can affect only the interest rate. Monetary policy is effective: a shift in the LM curve increases output by the full amount of the shift.

- e. This sentence is true. If money demand does not depend on income, then we can write the LM equation as

$$M/P = L(r).$$

For any given level of real balances M/P , there is only one level of the interest rate at which the money market is in equilibrium. Hence, the LM curve is horizontal, as shown in Figure 12-19.

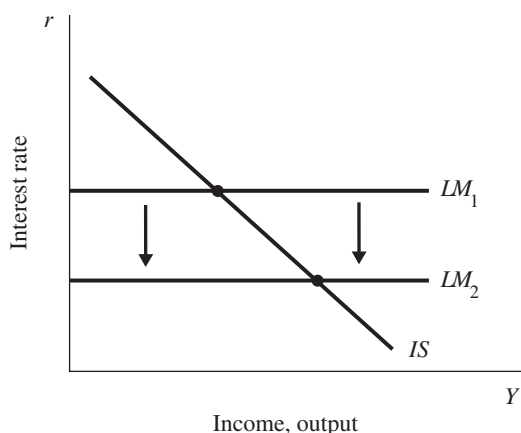


Figure 12-19

Fiscal policy is very effective: output increases by the full amount that the *IS* curve shifts. Monetary policy is also effective: an increase in the money supply causes the interest rate to fall, so the *LM* curve shifts down, as shown in Figure 12-19.

- f. This statement is true. The *LM* curve gives the combinations of income and the interest rate at which the supply and demand for real balances are equal, so that the money market is in equilibrium. The general form of the *LM* equation is

$$M/P = L(r, Y).$$

Suppose income *Y* increases by \$1. How much must the interest rate change to keep the money market in equilibrium? The increase in *Y* increases money demand. If money demand is extremely sensitive to the interest rate, then it takes a *very* small increase in the interest rate to reduce money demand and restore equilibrium in the money market. Hence, the *LM* curve is (nearly) horizontal, as shown in Figure 12-20.

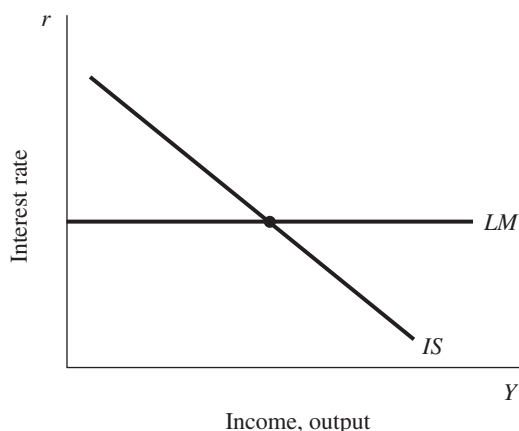


Figure 12-20

An example may make this clearer. Consider a linear version of the *LM* equation:

$$M/P = eY - fr.$$

Note that as *f* gets larger, money demand becomes increasingly sensitive to the interest rate. Rearranging this equation to solve for *r*, we find

$$r = (e/f)Y - (1/f)(M/P).$$

We want to focus on how changes in each of the variables are related to changes in the other variables. Hence, it is convenient to write this equation in terms of changes:

$$\Delta r = (e/f)\Delta Y - (1/f)\Delta(M/P).$$

The slope of the *LM* equation tells us how much *r* changes when *Y* changes, holding *M* fixed. If $\Delta(M/P) = 0$, then the slope is $\Delta r/\Delta Y = (e/f)$. As *f* gets very large, this slope gets closer and closer to zero.

If money demand is very sensitive to the interest rate, then fiscal policy is very effective: with a horizontal *LM* curve, output increases by the full amount that the *IS* curve shifts. Monetary policy is now completely ineffective: an increase in the money supply does not shift the *LM* curve at all. We see this in our example by considering what happens if *M* increases. For any given *Y* (so that we set $\Delta Y = 0$), $\Delta r/\Delta(M/P) = (-1/f)$; this tells us how much the *LM* curve shifts down. As *f* gets larger, this shift gets smaller and approaches zero. (This is in contrast to the horizontal *LM* curve in part (c), which does shift down.)

5. a. To raise investment while keeping output constant, the government should adopt a loose monetary policy and a tight fiscal policy, as shown in Figure 12-21. In the new equilibrium at point B, the interest rate is lower, so that investment is higher. The tight fiscal policy—reducing government purchases, for example—offsets the effect of this increase in investment on output.

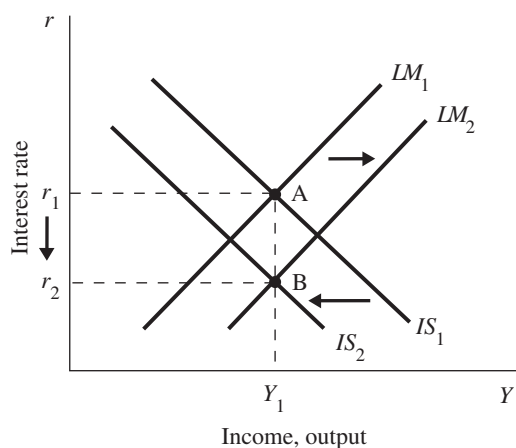


Figure 12-21

- b. The policy mix in the early 1980s did exactly the opposite. Fiscal policy was expansionary, while monetary policy was contractionary. Such a policy mix shifts the IS curve to the right and the LM curve to the left, as in Figure 12-22. The real interest rate rises and investment falls.

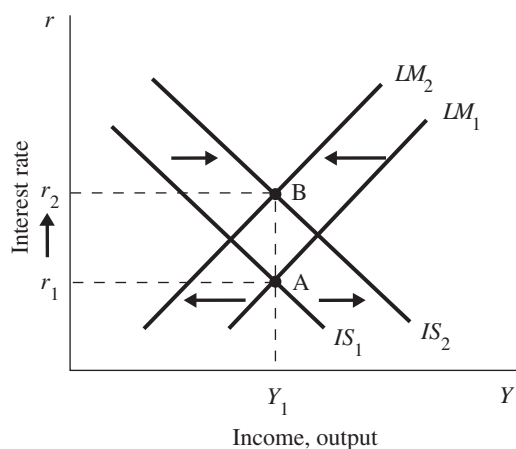


Figure 12-22

6. a. An increase in the money supply shifts the LM curve to the right in the short run. This moves the economy from point A to point B in Figure 12-23: the interest rate falls from r_1 to r_2 , and output rises from \bar{Y} to Y_2 . The increase in output occurs because the lower interest rate stimulates investment, which increases output.

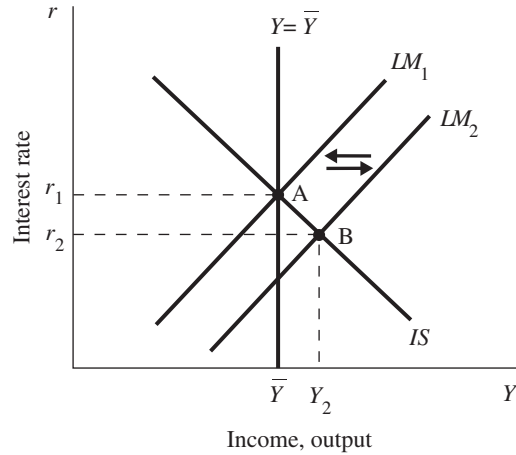


Figure 12-23

Since the level of output is now above its long-run level, prices begin to rise. A rising price level lowers real balances, which raises the interest rate. As indicated in Figure 12-23, the LM curve shifts back to the left. Prices continue to rise until the economy returns to its original position at point A. The interest rate returns to r_1 , and investment returns to its original level. Thus, in the long run, there is no impact on real variables from an increase in the money supply. (This is what we called *monetary neutrality* in Chapter 5.)

- b. An increase in government purchases shifts the IS curve to the right, and the economy moves from point A to point B, as shown in Figure 12-24. In the short run, output increases from \bar{Y} to Y_2 , and the interest rate increases from r_1 to r_2 .

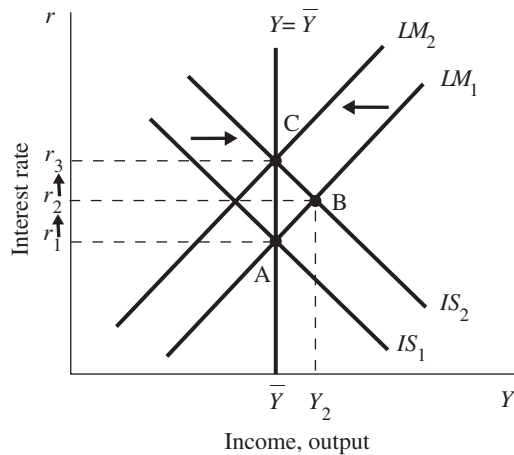


Figure 12-24

The increase in the interest rate reduces investment and “crowds out” part of the expansionary effect of the increase in government purchases. Initially, the LM curve is not affected because government spending does not enter the LM equation. After the increase, output is above its long-run equilibrium level, so prices

begin to rise. The rise in prices reduces real balances, which shifts the LM curve to the left. The interest rate rises even more than in the short run. This process continues until the long-run level of output is again reached. At the new equilibrium, point C, interest rates have risen to r_3 , and the price level is permanently higher. Note that, like monetary policy, fiscal policy cannot change the long-run level of output. Unlike monetary policy, however, it can change the *composition* of output. For example, the level of investment at point C is lower than it is at point A.

- c. An increase in taxes reduces disposable income for consumers, shifting the IS curve to the left, as shown in Figure 12-25. In the short run, output and the interest rate decline to Y_2 and r_2 as the economy moves from point A to point B.

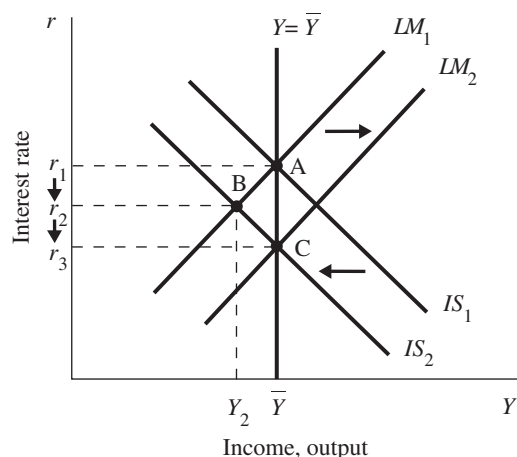
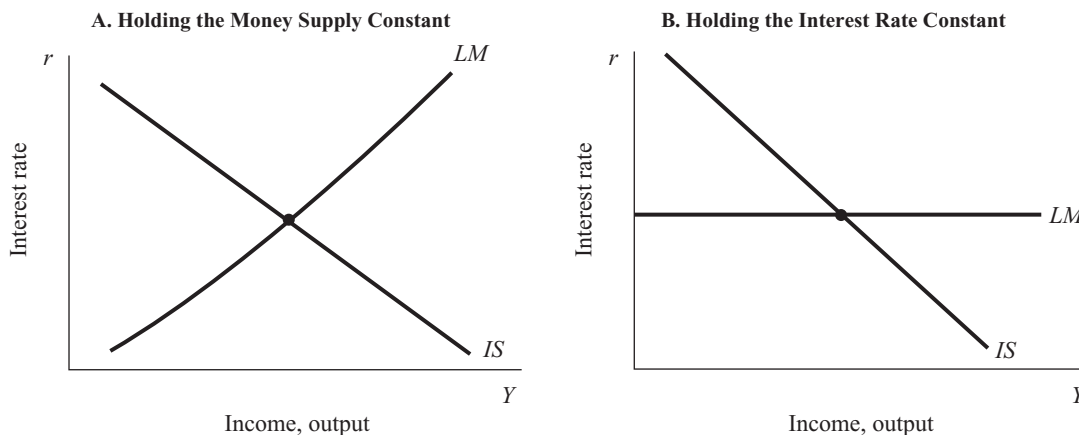


Figure 12-25

Initially, the LM curve is not affected. In the longer run, prices begin to decline because output is below its long-run equilibrium level, and the LM curve then shifts to the right because of the increase in real money balances. Interest rates fall even further to r_3 and, thus, further stimulate investment and increase income. In the long run, the economy moves to point C. Output returns to Y , the price level and the interest rate are lower, and the decrease in consumption has been offset by an equal increase in investment.

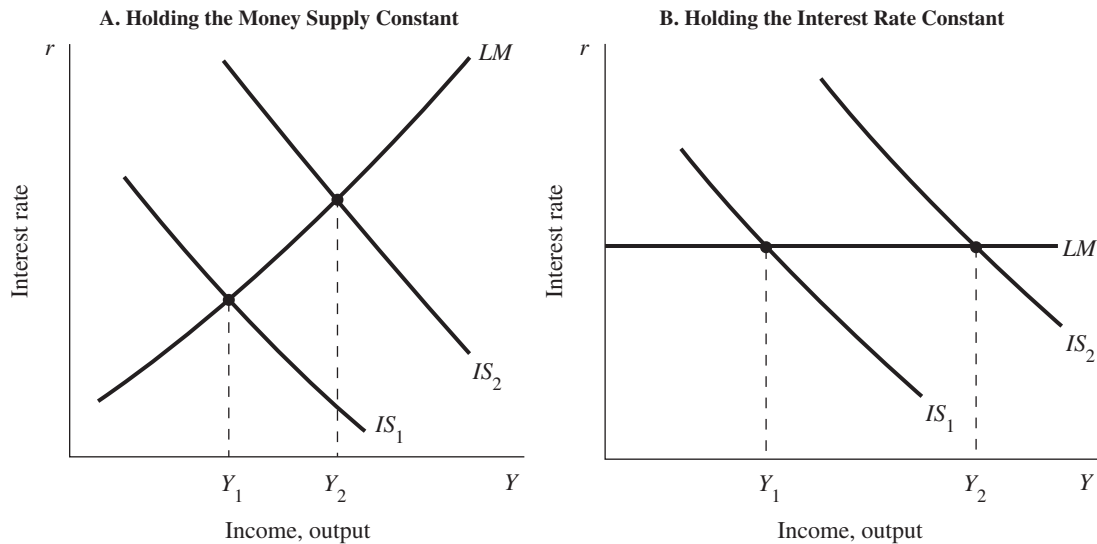
7. Figure 12-26(A) shows what the $IS-LM$ model looks like for the case in which the Fed holds the money supply constant. Figure 12-26(B) shows what the model looks like if the Fed adjusts the money supply to hold the interest rate constant; this policy makes the effective LM curve horizontal.

Figure 12-26



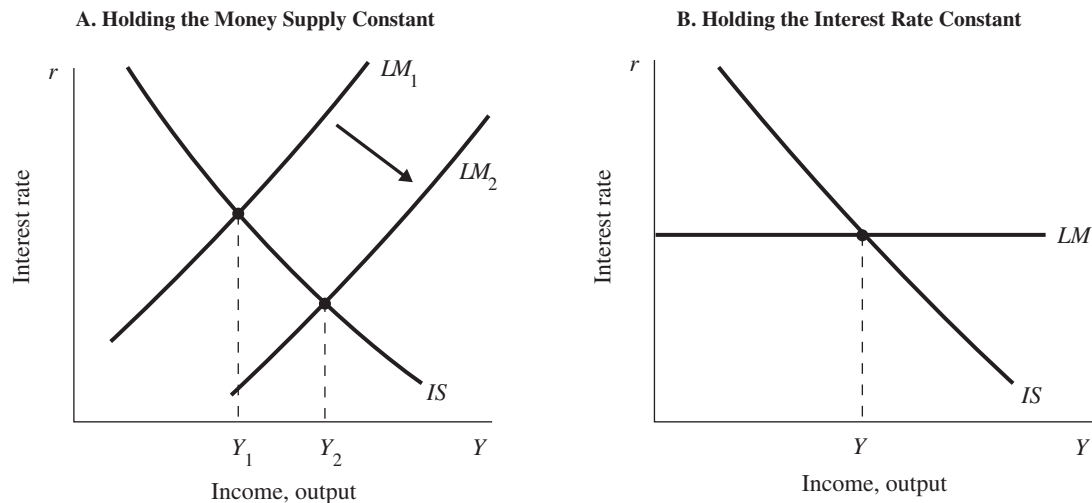
- a. If all shocks to the economy arise from exogenous changes in the demand for goods and services, this means that all shocks are to the *IS* curve. Suppose a shock causes the *IS* curve to shift from IS_1 to IS_2 . Figures 12-27(A) and (B) show what effect this has on output under the two policies. It is clear that output fluctuates less if the Fed follows a policy of keeping the money supply constant. Thus, if all shocks are to the *IS* curve, then the Fed should follow a policy of keeping the money supply constant.

Figure 12-27



- b. If all shocks in the economy arise from exogenous changes in the demand for money, this means that all shocks are to the *LM* curve. If the Fed follows a policy of adjusting the money supply to keep the interest rate constant, then the *LM* curve does not shift in response to these shocks—the Fed immediately adjusts the money supply to keep the money market in equilibrium. Figures 12-28(A) and (B) show the effects of the two policies. It is clear that output fluctuates less if the Fed holds the interest rate constant, as in Figure 12-28(B). If the Fed holds the interest rate constant and offsets shocks to money demand by changing the money supply, then all variability in output is eliminated. Thus, if all shocks are to the *LM* curve, then the Fed should adjust the money supply to hold the interest rate constant, thereby stabilizing output.

Figure 12-28



8. a. The analysis of changes in government purchases is unaffected by making money demand dependent on disposable income instead of total expenditure. An increase in government purchases shifts the IS curve to the right, as in the standard case. The LM curve is unaffected by this increase. Thus, the analysis is the same as it was before; this is shown in Figure 12-29.

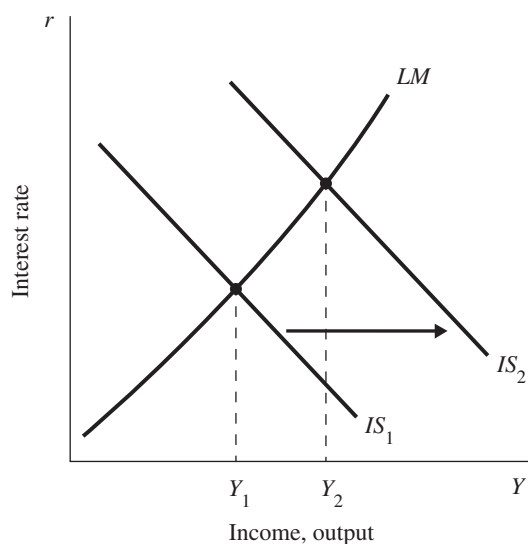


Figure 12-29

- b. A tax cut causes disposable income $Y - T$ to increase at every level of income Y . This increases consumption for any given level of income as well, so the IS curve shifts to the right, as in the standard case. This is shown in Figure 12-30. If money demand depends on disposable income, however, then the tax cut increases money demand, so the LM curve shifts upward, as shown in the figure. Thus, the analysis of a change in taxes is altered drastically by making money demand dependent on disposable income. As shown in the figure, it is possible for a tax cut to be contractionary.

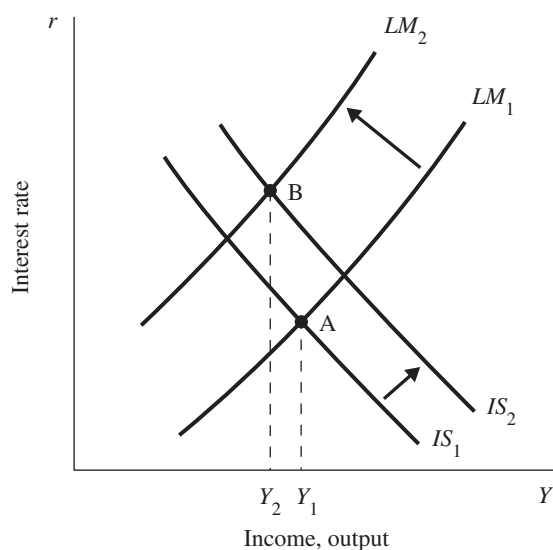


Figure 12-30

9. a. The goods market is in equilibrium when output is equal to planned expenditure, or $Y = PE$. Starting with this equilibrium condition, and making the substitutions from the information given in the problem, results in the following expression for equilibrium output Y :

$$Y = C + I + G$$

$$Y = C(Y - T) + I(r) + G$$

$$Y = a + b(Y - T) + c - dr + G$$

$$(1 - b)Y = a - bT + c - dr + G$$

$$Y = \frac{a - bT + c - dr + G}{1 - b}$$

- b. The slope of the IS curve is measured as

$$\frac{\Delta r}{\Delta Y}.$$

From the equation in part (a), the slope of the IS curve can be found as follows:

$$\frac{\Delta r}{\Delta Y} = \frac{1}{(\Delta Y / \Delta r)} = \frac{1}{-(d / (1 - b))} = -\frac{(1 - b)}{d}.$$

Mathematically, as the parameter d becomes a larger number, the slope becomes a smaller number in absolute value terms and the IS curve becomes flatter. Intuitively, if the parameter d is a larger number, then investment is more responsive to changes in the interest rate. Any given decrease in the interest rate will cause a larger increase in investment and, via the multiplier effect, cause a larger increase in equilibrium output Y . This makes the IS curve flatter.

- c. A \$100 increase in government spending will cause a larger horizontal shift in the IS curve than a \$100 tax cut. From the equation for equilibrium output in part (a), note that the impact of the tax cut depends on the marginal propensity to consume, as given by the parameter b . If the MPC is 0.75, for example, then a \$100 tax cut will shift the IS curve by only \$75. Intuitively, this makes sense because the entire \$100 increase in government spending will be spent, whereas only a portion of the tax cut will be spent, and the rest will be saved depending on the size of the MPC .
- d. Money-market equilibrium occurs where the demand for real balances is equal to the supply of real balances. Using the given information about the demand for real balances, we can solve for the equilibrium interest rate:

$$\frac{M}{P} = L(r, Y) = eY - fr$$

$$fr = eY - \frac{M}{P}$$

$$r = \frac{eY}{f} - \frac{M}{fP}.$$

- e. The slope of the LM curve is measured as

$$\frac{\Delta r}{\Delta Y}.$$

From the equation in part (d), the slope of the LM curve is e/f . As the parameter f becomes a larger number, the slope becomes smaller and the LM curve becomes flatter. Intuitively, as the parameter f becomes a larger number, money demand is more responsive to changes in the interest rate. This means that any increase in income that leads to an increase in money demand will require a relatively small increase in the interest rate to restore equilibrium in the money market.

- f. The size of the horizontal shift in the LM curve caused by a change in the money supply M can be measured by looking at where the LM curve crosses the horizontal axis. From the equation in part (d), set r equal to zero and solve for Y to find the horizontal intercept: the LM curve crosses the horizontal axis where $Y = M/eP$. Mathematically, a \$100 change in the money supply has a smaller effect on the horizontal intercept the larger the value of the parameter e . When the parameter e is larger, money demand is more responsive to changes in income Y , and the LM curve is steeper. Intuitively, if income increases and the parameter e is relatively larger, then money demand increases by a larger amount. This then requires a larger increase in the interest rate to restore money-market equilibrium and the LM curve becomes relatively steeper. Overall, the increase in the money supply will lower the interest rate and increase investment spending and output. When output rises, so does money demand, and if the parameter e is relatively large, then the interest rate will need to rise by a larger amount to restore equilibrium in the money market. The overall effect on equilibrium output is relatively smaller, as given by the smaller horizontal shift in the LM curve. The parameter f has no effect on the size of the horizontal shift in the LM curve caused by a change in the money supply. The parameter f affects the vertical shift and the slope of the LM curve but not the horizontal shift.
- g. To derive the aggregate demand curve, substitute the result for part (d) into the result for part (a) and solve for Y :

$$\begin{aligned} Y &= \frac{a - bT + c + G}{1 - b} - \frac{d}{1 - b} \left(\frac{eY}{f} - \frac{M}{fP} \right) \\ Y \left(1 + \frac{de}{f(1 - b)} \right) &= \frac{a - bT + c + G}{1 - b} + \frac{dM}{f(1 - b)P} \\ Y &= \frac{f(a - bT + c + G)}{f(1 - b) + de} + \frac{dM}{[f(1 - b) + de]P}. \end{aligned}$$

- h. The aggregate demand curve has a negative slope, as can be seen from the equation in part (g) above. An increase in the price level P will decrease the value of the second term on the right-hand side, and therefore output Y will fall.
- i. An increase in the money supply, an increase in government spending, and a decrease in taxes all shift the aggregate demand curve to the right, as can be seen from the equation for the aggregate demand curve found in part (g). Looking at the first term on the right-hand side, we see that an increase in G or a decrease in T will increase the value of this term and shift the aggregate demand curve to the right. Looking at the second term on the right-hand side, an increase in the money supply for any given value of the price level will increase the value of output and therefore shift the aggregate demand curve to the right. If the parameter f has a value of zero, then the first term on the right-hand side is zero and changes in government spending and taxes do not affect the aggregate demand curve. In this case, the LM curve is vertical and changes in fiscal policy that shift the IS curve

have no effect on output. Monetary policy is still effective in this case, and an increase in the money supply will still shift the aggregate demand curve to the right. In this case, the aggregate demand curve is given by:

$$Y = \frac{M}{eP}.$$